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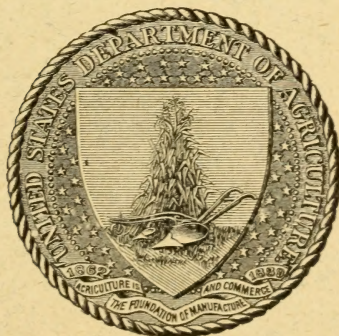
DIVISION OF CHEMISTRY.

ZINC IN EVAPORATED APPLES.

BY

HARVEY W. WILEY,

CHIEF OF DIVISION OF CHEMISTRY.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1896.

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BULLETIN No. 48.

U. S. DEPARTMENT OF AGRICULTURE.

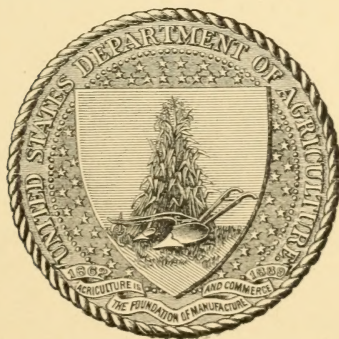
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF CHEMISTRY,
Washington, D. C., February 14, 1896.

SIR: I have the honor to transmit herewith, for your inspection and approval, the manuscript of a report of an investigation in regard to the presence of zinc in American evaporated apples, undertaken by authority of the Assistant Secretary, and to recommend the publication of the same as Bulletin No. 48 of this Division.

Respectfully,

HARVEY W. WILEY,
Chief of Division of Chemistry.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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CONTENTS.

	Page.
Investigations and analyses heretofore made.....	7
Sulphuring apples—objects.....	8
Process of evaporating fruits.....	10
Superiority of American evaporated fruits.....	11
Restrictions of trade in evaporated apples.....	12
Dried apples at Hamburg.....	12
Dried apples at Cologne.....	14
Analyses undertaken by the Department.....	15
Restrictions against American dried apples in Germany.....	15
Action of the imperial government.....	16
Collection of samples at New York factories.....	20
Views of dealers in evaporated apples.....	20
Methods of analysis.....	23
Hefelmann's method of detecting zinc in evaporated apples.....	24
Niederstadt's method of determining zinc.....	24
Legler's improved process.....	25
Filsinger's method.....	25
Methods of analyses employed in the laboratory of the Division of Chemistry.....	25
Analytical work.....	26
Description of evaporated apples analyzed.....	26
Discussion of data obtained.....	28
Examination of the galvanized iron wire used in making the trays.....	32
Physiological action of zinc.....	33
Zinc as a natural content of apples.....	34
Substitution of other material for galvanized iron wire in the manufacture of trays.....	34
Summary.....	35

ZINC IN EVAPORATED APPLES.

The development of the evaporated fruit industry in this country has rendered available for export large quantities of evaporated apples. By reason of the modern improvements in the methods of evaporation, the desiccated apples retain to a remarkable degree their freshness and flavor. After preparation for the table, the evaporated fruits are scarcely distinguishable from their fresh state either in color or taste.

In the last few years many objections have been made in foreign countries to the use of evaporated fruits on account of their contamination with zinc. By reason of the complaints made by exporters and consular agents, the Secretary of Agriculture authorized an investigation to be made for the purpose of determining whether evaporated apples contain zinc, and if so, whether in quantities prejudicial to health.

INVESTIGATIONS AND ANALYSES HERETOFORE MADE.

In beginning this investigation a search was first made in the literature of the subject to find out what had been accomplished in the matter heretofore, and to learn the methods of investigation and analysis employed.

In 1886 a large number of samples of evaporated apples was examined by Prof. S. A. Lattimore, of Rochester, N. Y., and the report of his work was published in the Sixth Annual Report of the State Board of Health of New York. The samples collected by Dr. Lattimore were dried on galvanized iron trays. At that time, he states, it was the custom of the manufacturers to sulphur the apples after they were sliced, so that the surface of the slices saturated with sulphurous acid was brought into direct contact with the galvanized iron during the process of drying.

No traces of zinc were found in the samples examined by Professor Lattimore, and this seems strange in view of the experience of our own and other analysts. Nevertheless, it was noticed that the galvanized iron wires suffered oxidation and lost zinc. In a given sample of the wire cloth used in making the bottoms of the trays, 33 per cent of its weight of zinc was found. In another sample of the same cloth, used for three years, only 9 per cent of zinc was found. This shows a loss of 24 per cent of zinc, which, it is explained, was caused principally by mechanical means. Dr. Lattimore concludes that there can exist no well-founded cause of apprehension of any dangerous contamination of evaporated apples with zinc, and it is a matter of congratulation in

the manufacture of an article of food so extensively used and likely to come into still more common use that there exists but slight possibility of the deterioration of the nutritive value of the product by the addition, incidentally or otherwise, of any foreign substance.

In the report of the dairy commissioner of New Jersey for 1890 occurs an article on dried apples by Professor Cornwall, of Princeton. Professor Cornwall analyzed 18 samples of dried apples purchased from dealers in various parts of New Jersey. Of this number 4 contained no zinc, in 2 traces of zinc were found, and in the other 12 were separated weighable quantities thereof. The largest percentage found was 0.18, and the smallest 0.002. In only one case out of the 18 is the amount of zinc sufficient to cause any suspicion. In the other cases, where zinc was present at all, its quantity was insignificant and wholly incapable of producing any poisonous effect whatever upon the organism.

Cornwall, in quoting from Lattimore's report (Report of the Dairy Commissioner of the State of New Jersey for 1889, p. 46), states that the apples in the process described by Lattimore are dried in an atmosphere of sulphurous acid derived from burning sulphur, the fruit being spread on screens of galvanized iron wire. This statement, however, does injustice to Lattimore's report, as will be seen further along.

SULPHURING APPLES—OBJECT.

While inspecting the processes used in the evaporation of apples in the principal factories in northwestern New York, in the autumn of 1895, it was observed that sulphuring in every instance was accomplished by exposing the apple, after the removal of the skin and core, to the action of the fumes of burning sulphur. The apples during this process are held on wooden trays, and in no observed case were they sliced before the sulphuring process. It is often stated that the sulphuring is accomplished after the apples have been sliced and placed upon the galvanized iron trays. If this ever was the custom, it has been abolished, and there seems to be no possibility from the manner in which the sulphuring is now accomplished of the process contributing in any way to increasing the amount of zinc present. The object of the sulphuring is twofold. In the first place, it prevents the darkening of the freshly-cut surface of the fruit. By reason of the oxidizing effects of the air the freshly cut surfaces of apples soon turn brown. The sulphuring prevents this and preserves the natural color of the fruit for a considerable period when exposed to the air. It might be supposed that the sulphuring of the whole apples before slicing would not be sufficient to preserve the fresh color of the surfaces after slicing. During the short time to which the apples are exposed to the fumes of burning sulphur, not exceeding, as a rule, half an hour, it might be supposed that the action of the sulphurous acid would be wholly superficial. Nevertheless, experience has shown that this method of procedure is quite sufficient to preserve the natural color of the slices and to pre-

vent them from becoming dark during the process of evaporation. At the same time the quantity of sulphurous acid which is absorbed is not sufficient to in any way impair the flavor of the fruit nor to give it any odor of sulphurous acid when packed in boxes for shipment.

The second advantage which arises from sulphuring the fruit is in preventing the growth of insects in the evaporated product. While it is evident that the process of sulphuring is in no sense a sterilizing proceeding, yet it seems sufficient to prevent insects from depositing their eggs upon the evaporated slices, at least to a certain extent. Nevertheless, we have found insects in some of the samples collected for analysis. These insects have been studied by the Division of Entomology, and the following varieties have been identified: *Ephestia elutella*, *Ephestia interpunctella*, and *Silvanus surinamensis*. The first of these insects has not been previously known to infest dried apples, but it is commonly found in cacao beans, figs, and English walnuts.

As a further protection against insects in dried fruits, Hilgard states that the sulphuring is sometimes repeated after the evaporation. (California Agricultural Experiment Station, Bulletin 86.) This process, however, is to be condemned, because the dried fruit retains more persistently the sulphurous acid, which affects very seriously its flavor, giving to a freshly opened package the odor of burning sulphur, supplanting entirely the pleasant ethereal odor which the fruit should emit. According to Hilgard, the consumer has reason to object to the sulphuring of the dried fruit for two reasons, one of which is that the ill-prepared or damaged fruit which otherwise could not be sold is bleached and made presentable in market, and, second, that the flavor of the fruit is either seriously impaired or totally destroyed. Such a resulphured fruit contains also considerable quantities of the sulphurous acid, the excessive consumption of which may impair digestion and affect the health of the consumer. Finally, the excess of sulphurous acid in evaporated fruits becomes converted by gradual oxidation into sulphuric acid. The amount of sulphuric acid which has been found in such sulphured dried fruits is six times as great as that which occurs in unsulphured samples of the same variety. Hilgard suggests, as a substitute for sulphuring, dipping the sliced apples for a few minutes into a solution of salt containing about two ounces of common salt to five gallons of water. This process prevents any spotting where the fruit has been touched. Instead of the salt a similar solution of the bisulphites of soda or lime may be used, which effects a slight external bleaching without injury to the flavor of the fruit.

It is doubtless true that even the superficial bleaching to which the apples are subjected in the process of evaporation as now carried on, tends to increase, in a slight degree, the quantity of sulphuric acid in the ash of the evaporated fruit. It is not believed, however, that this increase is in any way prejudicial to health or objectionable from any point of view. It can not be denied that attractiveness of appearance

does something more than merely please the eye in food products. The impression produced by food of an attractive appearance tends to stimulate the activity of the gastric cells and to promote in many ways the process of digestion. The fresh appearance of evaporated fruits secured by the moderate bleaching which has been described is, in my opinion, of value, and fully justifies the process. It is only when the bleaching is overdone, or when it has been applied in excess to fruits already discolored and dried, that it can be justly condemned.

The sulphuring process as described by Lattimore in 1886 (Sixth Annual Report of the State Board of Health of New York) was conducted as follows:

The apples are pared, cored, and sliced by machines which are operated with great rapidity, either by hand or steam power. The slices, which are about half an inch thick, are placed in shallow trays or drawers which are transferred to a closed box, in the base of which a small quantity of sulphur is kept burning. The arrangement is such that a number of these trays may be introduced at the same time, one above the other, and all exposed to the fumes of burning sulphur as it circulates among them, finally escaping into the chimney. After being submitted to the sulphuring treatment, the slices are transferred to the drying screens, consisting of light rectangular wooden frames supporting the wire cloth, woven of iron wire coated with zinc.

This method, as has already been stated, has been superseded by the more modern one of applying the sulphur fumes before slicing.

PROCESS OF EVAPORATING FRUITS.

In the modern processes of manufacture the object has been to secure the fruit in an evaporated state as soon as possible after the commencement of operations upon it. It is not the purpose here to describe the drying kilns and the machinery by means of which the apples are prepared. Those interested in a study of modern drying kilns can find them fully described by Professor Bailey, in Bulletin 100, of the Cornell Agricultural Experiment Station. In four of the largest factories for the manufacture of evaporated fruits in northwestern New York the process as observed by personal inspection is conducted as follows:

The apples are pared and cored by machinery, after which they are placed in wooden trays with perforated bottoms and transferred to a wooden box which serves as a chimney for conducting off the fumes of burning sulphur. The arrangement of this box in some cases is quite ingenious. In one instance the trays are carried through a box, which lies in a horizontal position, by a slowly revolving continuous apron, consuming about twenty minutes in transit. In other instances different mechanical devices were noticed, but the process was essentially the same in all cases.

The sulphured apples are next passed to a slicing machine, in which the knives and other parts in contact with the fruit are made of bronze. By this machine they are cut into slices a little more than a quarter of an inch thick, each perfect slice having a circular perforation in the center caused by the previous removal of the core. It is this appearance of

the slices which has given evaporated apples in Germany the common name "Ringäpfel." After slicing, the pieces are spread in thin layers on shallow trays of different sizes, made in every instance observed by me of galvanized iron wire. The slices should not be more than two deep, and in order to secure an even and uniform drying should not stick closely together. The trays, when filled, are transferred to large drying furnaces heated with steam or hot air, and the temperature and draft so regulated as to secure the required degree of desiccation in from three to four hours. It should be noted here that before beginning the operations above mentioned the apples are passed through screens, to separate them into grades of uniform size, and all decayed or injured fruit is removed. After the apples are pared they are again examined for decayed spots, and these, if not too large, are removed with a knife before the apples are sulphured and passed to the slicing machine.

After the trays are removed from the drying kilns the evaporated slices are removed and any imperfectly dried slices separated and thrown together for subsequent additional evaporation. In some instances I noticed that the trays were oiled from time to time, to prevent the evaporated slices from sticking thereto. The evaporated fruit is thrown into large heaps on a clean floor and allowed to remain for about two weeks, being occasionally turned over with a shovel. By this process the slices all acquire a uniform percentage of moisture. They are then sifted, so as to secure them in sizes of uniform dimensions, after which they are packed, usually with the help of pressure, into boxes suited for shipment, as a rule 50 pounds being placed in each box. The quantity of perfect fruit secured in an evaporated state is not far from 12 per cent of the gross weight of apples entering the manufactory. Cores and skins may be dried and used for flavoring jellies, etc., or they may be pressed for the purpose of cider making. In the latter case it is found that about one gallon of cider is secured for each bushel of apples used.

I am told that in many establishments, in order to avoid the danger of contaminating the evaporated fruit with zinc, trays are employed in which the bottoms are composed of wooden slats or canvas. The objection to the use of wood in the manufacture of the trays lies in the fact that the parts of the sliced apples lying in contact with the wood are imperfectly dried, so that the product is not of uniform nature. On the other hand, when evaporated apples are manufactured for the purpose of shipment abroad, to countries where sanitary inspection is exercised, the advantage of drying on wooden trays is manifest, allowing of a guarantee being given of the entire freedom of the product from zinc.

SUPERIORITY OF AMERICAN EVAPORATED FRUITS.

American evaporated apples, on account of their good taste and attractive appearance, are much preferred by the German public to the domestic product. Their consumption has also proved to be of advan-

tage to the human body as a tonic aside from their nutritive value, and this is doubtless due to the iron they contain, which is probably derived from the machines used for cutting them. Many of the kinds which are found in commerce, however, have been found zinciferous, due to the zinc contained in the trays for holding them during drying. For several years, therefore, the Prussian, at the instance of the Hamburg authorities, have insisted upon having a certificate to the effect that the evaporated fruits offered for sale have not been dried in contact with galvanized iron wires. All the apples in a case will not be found adulterated, which comes from the fact that only the lower layers in the drying apparatus are brought in contact with the zinc. Niederstadt concludes from his examinations that it is very doubtful whether the evaporated fruit containing zinc is injurious to health, inasmuch as the content of zinc has been found in all cases a very small one, amounting in the largest quantities found to not more than seven-hundredths of 1 per cent. (*Chemiker-Zeitung*, vol. 19, p. 1757.) In his own family, where this fruit has been used for years, not the slightest injurious effect has ever been noticed. It is quite certain that the zinc which may be present in preserved fruits and vegetables coming from the solder should be far more an object of suspicion than that which is contained in evaporated apples.

RESTRICTIONS OF TRADE IN EVAPORATED APPLES.

In a few German cities the sale of American evaporated apples has been practically prohibited unless a certificate be furnished to the effect that they contain no zinc. By reason of this police regulation the trade has been very much injured and in some quarters almost destroyed. In so far as can be ascertained, no limits have been fixed in regard to the quantity of zinc which the evaporated fruit may contain, except as mentioned below, but all samples containing zinc are excluded from the trade. As an illustration of the character of the regulations in regard to the sale of the fruits, the action of the police authorities of Hamburg and Cologne may be cited.

DRIED APPLES AT HAMBURG.

In the report of W. Henry Robertson, United States consul at Hamburg, dated October 29, 1894, the following comments are made on the trade in American dried apples in Germany (Consular Report, 171, p. 89):

I have ascertained in a semiofficial way that a movement is now being set on foot by the Imperial German Government, and is already engaging the attention of the authorities of this city and, I presume, of the other cities of the Empire, looking to the complete exclusion under the imperial law regarding the traffic in articles of food, etc., of May 14, 1879, of dried and evaporated apples from the United States which are found on arrival in Germany to contain more than a specified quantity of metallic zinc, arising from the drying of the apples on zinc plates or frames.

Each locality determines for itself what quantity of zinc the apples consumed

therein can contain without being detrimental to health; but the tendency would seem to be to exclude the fruit when found to contain any zinc whatever. The laws of Hamburg prohibit the sale or offering for sale of apples having more than 0.01 per cent of metallic zinc. By metallic zinc is meant the actual amount of the metal left after separating the chemical combination of zinc and the acid of the apples.

For a number of years dried apples in the form of slices, pieces, or rings have been imported into Germany from the United States, and it has been observed that this fruit often contains zinc in such quantities that, according to medicinal authority, the consumption of the same may prove detrimental to health. The German authorities have, in consequence, since about five years ago endeavored by every possible means to prevent the importation of American dried fruits containing zinc and to bring about the judicial punishment of the venders of such merchandise.

In many cities, as, for instance, Hamburg, large quantities of American dried apples containing zinc have been confiscated by the police authorities or forcibly reexported. The courts have, in many cases, unequivocally decreed that the sale of dried apples containing zinc must be regarded as an offense against the German food law, in so far as the consumption of articles of food containing zinc shall be liable to injure human health.

The opinion of the medical authorities regarding the contents of zinc of the American dried apples is that the smallest quantities of zinc may lend articles of food qualities detrimental to health.

Of late the control of American dried apples in Germany has become more rigid, on account of an appeal of the German chancellor to the federated governments, requesting them to instruct the respective authorities to supervise the traffic in these goods, to have samples examined by food chemists, and, if found necessary, to lodge complaints against the sellers of goods injurious to health.

The sequel to these investigations is not unlikely to be the issuing of an order forbidding the sale in Germany of apples containing zinc.

There is no doubt that the American trade in dried apples would suffer severely through such a measure, and the only way for the purchasers of such goods to protect themselves against losses would be in the removal of the causes for the existence of zinc in the apples.

It is safe to assume that these causes are not attributable to any condition of the soil, but that the zinc gets into the apples during the drying process on zinc plates or frames, the acid of the apples chemically absorbing zinc.

Although by the employing of zinc plates or frames the dried apples retain a fine, light color, it would not seem to be advisable to employ such means for the sake of a comparatively small and purely external advantage.

Racks or frames of wood can be used just as well as those made of metal, or the apple slices might even be strung upon strings or cords. These methods are often employed in Germany, and, therefore, the brownish color of the products obtained through them would not put them to any disadvantage so far as their importation into Germany is concerned.

The above are almost the literal ideas of a gentleman here with whom I have conversed fully on this subject, and who has given me much valuable information.

While the object in making this report is to warn our exporters of dried fruit and other food products that it is all-important that, at this particular juncture, the articles sent by them to this country should be so prepared in every way as to offer no grounds for complaint on the part of either German officials or competing dealers here, such as might be successfully used to injure or destroy our trade, I do not feel disposed to admit, by any means, without further proof, the full extent of the alleged defects in our food products that are being claimed here.

Exporters who really send to this country unhealthy and inferior articles must and ought to expect disadvantages for their goods when competing with purer ones; but I feel convinced that our Government, upon the proper representations,

will take all the necessary steps to protect the healthful and unadulterated wares of our exporters from unfair and unreasonable interference when offered for sale in the markets of Germany, and that it will use every means to prevent any restrictions being imposed upon them here, save such as are actually justifiable from a sanitary standpoint, and such as are applied to similar articles when produced here or imported from other countries than the United States.

DRIED APPLES AT COLOGNE.

In a report of William D. Wamer, the United States consul at Cologne, dated February 9, 1895, the text of an order warning the public against the consumption of American evaporated apples was given. The full report is as follows:

An order has just been issued by the police administration of Cologne and published in the local papers warning the public against eating sliced American dried apples. It says that large quantities of such apple slices, chiefly of American origin, are offered for sale here which contain a larger or smaller quantity of zinc. Of 13 samples selected for investigation, 11 are said to have contained zinc. It asserts, further, that the presence of zinc is due to the fact that the apple slices from America are not dried, as is done here, on wooden racks, but on zinc netting. By this process there is formed in the apples malate of zinc, which has an analogous operation to that of lactate of zinc. According to experts, the eating of such an article may undoubtedly be injurious to health, especially to children and those who have weak constitutions. Continuing, the mayor of the city says:

"I therefore feel obliged to give strict warning against the sale and the eating of American dried apple slices, and give notice to those offering such articles for sale that they will be proceeded against in accordance with the imperial law regulating the trade in food and food products."

There is a considerable trade in this market in American dried apples, and I am informed by an agent representing a large Chicago firm here that this order will frighten the public against eating such apples, and thereby injure, if not destroy altogether, this trade.

According to the statistics for the German Empire, there were imported into Germany from the United States in 1893, 2,968 tons, and in 1894, 2,133 tons of dried fruit, which I understand to be dried apple slices.

In a supplemental report of the same consul, dated February 11, 1895, attention is called to some modifications of the order, the nature of which will be indicated by the selections from the report given below:

Supplementary report.

Referring to my report forwarded to the Department of State under date of February 9, I have to report further that a number of the dealers here in American dried apple slices have since appealed to the mayor of Cologne to modify his warning to the public under date of the 6th instant so as not to prejudice consumers against such apple slices that are dried (evaporated) on wooden racks and contain no zinc. This has been done publicly by the mayor as follows:

"My notice of the 6th instant has given rise to the misunderstanding that the eating of American evaporated apple slices are injurious to health, and those persons offering such article for sale would be punished. This is by no means the case. The notice has reference only to such American dried apple slices as have been dried on zinc netting and contain zinc, and not to those that have been dried on wooden racks and contain no zinc."

If the American firms desire to hold on to this already thriving American trade in this market, they are advised to evaporate the apples only on wooden racks and see

to it that the apples so prepared are entirely free of zinc, as the mere traces of this ingredient would cause them to be objected to by the health officials. One agent has suggested to me that it would be advisable for the American firms to furnish with each shipment an authenticated certificate that the apples have been analyzed by an expert chemist and are absolutely free from zinc.

ANALYSES UNDERTAKEN BY THE DEPARTMENT.

In view of the information contained above, analyses were ordered, and it was suggested that, in view of the restrictions referred to, an examination be made of the fruits intended for shipment to foreign ports, and, further, that the State Department be requested to ask our consuls in localities where trade in American evaporated apples was restricted or prohibited, to procure samples, especially of those fruits which were condemned for sanitary reasons, and transmit them to this Division for analysis.

In harmony with these recommendations, instructions were given to secure samples of evaporated apples from exporters in New York City and from the manufacturers, and a communication was directed to the Secretary of State soliciting the cooperation of the consular officers, which was cheerfully granted, and resulted in the receipt, in due time, of samples of evaporated American apples from Frankfort, Germany, together with the following reports:

RESTRICTIONS AGAINST AMERICAN DRIED APPLES IN GERMANY.

[Report by Consul-General Frank H. Mason at Frankfort.]

In response to recent instructions of the Department, requiring the collection and return of samples of dried American apples which have been condemned by the health authorities in this district for their alleged contamination with salts of zinc, I have to submit, with the accompanying samples, the following report, which will explain in some degree the nature and scope of the restrictions which threaten, under existing conditions, to practically exclude from German markets one of the important minor food products of the United States.

On the 14th of May, 1879, there was enacted in Germany a national law for the protection of the people from danger through the sale of adulterated, impure, or unwholesome articles of food, drink, or medicine. For the enforcement of this law there is in each district or municipality a "Gesundheits-Amt," or bureau of sanitary police, which is charged with the inspection of all food materials, drinks, etc., that are offered for sale within its jurisdiction. Under the scrutiny of these officials evaporated apples of American origin have been from time to time during the past two years condemned on the charge of containing a small admixture of malate of zinc, presumably the result of contact, while drying, with trays made of perforated zinc or galvanized-iron wire. Whether this contamination ever reaches such a degree as to render the fruit actually unwholesome is a point concerning which the German chemists, health officials, and importers have not yet been able to agree, and the controversy has now reached an acute and somewhat perplexing stage.

In November, 1892, an official declaration was issued by Dr. Zimmermann, chief health officer, and Dr. Loock, principal of the royal food inspection bureau for the city of Düsseldorf, concerning the presence of zinc in American evaporated apples. (See Exhibit A, page 19.) In his statement Inspector Loock states that he had at various times analyzed samples of American evaporated apples, and had in most cases found them free from any admixture of zinc. Such as had been found con-

taminated with salts of zinc contained usually from one-hundredth to five-hundredths of 1 per cent of that material, and the highest percentage ever found by him was 0.09 per cent, an amount of zinc which he declares to be wholly insufficient to render apples prejudicial to human health when cooked and eaten in the ordinary manner. In his accompanying certificate Health Officer Zimmermann confirms this statement of the inspector, and asserts that the maximum quantity of malate of zinc that could be consumed by a person at one meal by eating apples containing the highest admixture yet detected would be less than one-fourth of an ordinary dose of acetate of zinc such as is frequently administered in medical practice, and he thereupon declares the dried apples in question to be manifestly devoid of danger to consumers.

ACTION OF THE IMPERIAL GOVERNMENT.

Notwithstanding this and other similar testimony, the agitation against American evaporated apples continued, and on the 16th of April, 1894, a circular letter was issued by the imperial ministry at Berlin, addressed to the governments of the several States, calling their attention to the dangerous character of American dried apples, and recommending special precautions for their inspection. This mandate, an original copy of which is herewith transmitted, is translated as follows:

[Empire of Germany. Circular from the imperial chancellor to the governments of the German States concerning American dried apples. From the 16th April, 1894.]

"It has been observed that various dried apples, especially those of American origin (evaporated apples), which contain a greater or less percentage of zinc, have been offered for sale. This peculiar defect in these goods is ascribed principally to the drying process employed in America, by which the fruit is evaporated, not as with us upon wooden trays, but upon zinc plates and nets of zinc-covered wire. Whether these apples are not purposely powdered with zinc oxid to give them a more attractive appearance, or whether in some cases this impregnation may be due to the fact that the fruit has been grown upon soil containing an admixture of zinc, are questions which are for the present left out of the account. But at all events, there has been found repeatedly in these goods so high a proportion of malate of zinc that in the opinion of competent experts they are undoubtedly prejudicial to human health, especially since it is to be observed that the forms of food prepared from dried apples are often eaten by persons of weak resistance, such as children and convalescents.

"In order to avert this danger the already existing law provides an adequate remedy, since by the provisions of paragraphs 12, 14, and 15 of the food-product law (*Nahrungsmittel-Gesetz*) of May 14, 1879, repressive measures may be taken when it is established that the apples contain so high an admixture of zinc as to be prejudicial to health. In fact, such measures have been successfully taken under the authority of the above-cited paragraphs—as is shown by the publications of the Imperial bureau of health, page 658, volume of 1890, and page 115, volume of 1893—against sellers of apples containing zinc; at least the goods were seized and confiscated.

"For the protection of the public against sanitary dangers from the food material now under consideration, it is hereby recommended that the officials and sanitary police who are charged with the execution of this law shall pay especial attention to the sale of dried apples; that they take from time to time samples of such as are exposed for sale and submit the same to examination by the inspecting chemists of food materials, and that they institute proceedings against the sellers of unwholesome goods,

"I request that you will bring this matter to the attention of the proper officials, and give such instructions as may be necessary to carry the law into effect. In case that successive or important cases of this nature may be found within your jurisdiction, you are requested to report the facts to this Department in order that if necessary further and more stringent regulations may be provided, perhaps by the entire suppression of the sale of apples containing zinc, under authority of paragraph 5, section 2, of the food-product law.

"By order of the imperial chancellor:

"VON ROTTENBURG."

In compliance with this mandate, instructions were issued by the royal ministries of Prussia, Saxony, Württemberg, and Bavaria. The edict was officially published in the organ of the imperial health department for July 25, 1894, and since that time all evaporated apples offered for sale in Germany have been subject to the most careful scrutiny.

One of the first cases which came to trial under these regulations was that of two grocers at Halle, named Baarmann and Werther, who were indicted before the royal civil court of that city for having sold American evaporated apples containing 0.096 per cent of malate of zinc. With them were also indicted and tried Nicolaus Haas and Fr. Arnold Ritter, of Hamburg, the importers from whom the condemned goods had been obtained, and who were therefore held as accessory to the crime. After a fair and full trial, in which the chief health officer of Halle and the sworn chemical expert of the court gave elaborate and precise testimony, the accused were all acquitted and the costs of the suit assessed by judgment upon the treasury of the State. The grounds upon which the court gave this judgment were, briefly, that according to the expert evidence adduced, dried fruit containing the alleged proportion of malate of acetate or zinc could not be considered dangerous to human health, since doses of those salts four times greater than the utmost quantity which a person would consume in a day from eating food prepared in the usual way from dried apples are frequently prescribed in medical practice to the same patient during several successive days without danger of any injurious result. In other words, although the apples under consideration might contain, as charged, a small trace of salts of zinc, the admixture was not sufficient to render them unwholesome, and therefore neither the importers nor grocers who offered them for sale were amenable to penalty nor the goods to seizure.

PROCEEDINGS AT FRANKFORT.

In February of the present year a lot of 25 cases of evaporated apples were imported from Rochester, N. Y., by Mr. Erwin Roelker, of this city, and sold to a local grocer named Latscha. The latter, in order to avoid danger of arrest or confiscation of his goods, took the precaution before offering them for sale, to submit a sample for analysis to a private chemist of high authority, who found them to contain 0.018 per cent of malate of zinc. The apples were thereupon returned by Mr. Latscha to the importer, who, not being satisfied with the result, sent a sealed sample from the same box to the same chemist, without stating from what lot the sample had been taken. The analysis of this second sample showed that it contained only 36.6 milligrams per kilogram, or 0.0036 per cent, of zinc, an admixture so minute as to be hardly discernible by the most delicate process.

Mr. Roelker thereupon applied formally by letter to the police authorities of Frankfort to know whether an admixture of 0.018 per cent of salts of zinc—which had been found by the first analysis above described—would be held sufficient to render dried apples unwholesome and subject the goods to seizure or the seller to prosecution. He received in reply an official statement that an admixture of 0.018 per cent of salts of zinc exceeded the limit of safety, and that if fruit containing that percentage were sold by him he would be liable to prosecution. He then appealed to the provincial government of this department in a long letter, citing

the above-quoted decisions from Düsseldorf and Halle, protesting that he had imported and sold American evaporated apples in large quantities during the past fifteen years without ever receiving or hearing of a single complaint from any retailer or consumer of such fruit; that no objection had ever been raised against American apples in any European country except Germany, and, after urging that since the recent tariff reductions in the United States such discrimination against a standard American product was at least ill timed, he asked that the prohibition which the Frankfort police authorities had put upon his trade should be overruled and canceled by departmental authority. To this petition, which was sent on the 19th of February last, no answer has yet been received, and Mr. Roelker's imports of evaporated apples have been discontinued.

About the same time—January, 1895—two boxes of similar apples from a lot received by another Frankfort importer from Chicago were sold to a local retailer named Wiegand, who exposed them for sale in his store. A policeman came, purchased a small quantity, and afterwards returned with a warrant summoning Wiegand to appear for trial at a specified date for violation of the law. Such of the apples as remained unsold were sealed up by order of the court and their further sale forbidden. The trial has been postponed and fixed for four successive dates, the last of which is the 31st of this month. So far as can be ascertained, these repeated postponements have been due to the inability of the court to reconcile or decide between the conflicting analyses of the chemists who have tested the fruit and the diverse opinions of medical experts as to where the danger line in zinc adulteration should be drawn.

The wholly different analyses which may be honestly derived from samples taken from one box of apples, or even from different portions of the same sample, are readily explained by the fact that any sample of say half a pound may contain pieces which have rested upon the tray while drying, while the overlying pieces, not having touched the metallic bottom of the tray, are wholly free from any trace of zinc. But as the presence of one or more contaminated pieces in a box may be sufficient under the present German system to condemn an entire box or shipment, it follows that the future dried apple export trade to this country will depend upon such merchandise being made absolutely free from any trace of zinc.

Meanwhile, earnest protests have been submitted, November 30, 1894, by the chamber of commerce at Hamburg to the committee of the Reichstag on commerce and navigation, and by the chamber of commerce at Bremen to the sanitary bureau in that city, both disclaiming against the present methods of surveillance, declaring the alleged danger from American dried apples to be imaginary, and protesting against a system which if continued will practically exclude from Germany an article of trade which other nations accept without question.

Nine leading firms at Berlin, Breslau, Strasburg, and Frankfort have signed a circular letter declaring that they have each during the past fifteen years sold annually from 500 to 1,000 boxes of American evaporated apples, and that so far as is known to them not a single case of illness has ever occurred from their consumption by persons of all ages and physical conditions. It is further urged by those who protest against the present system that if dried apple imports are to be controlled at all, the inspection should take place at the frontier, and exclude all that are found to be impure, whereas they are now allowed to be entered and are condemned and confiscated only after they have paid duty as imports.

The general situation may therefore be summarized as follows: The importation of American dried fruits to Germany on a large scale began about fifteen years ago, and now amounts to about a million and a half pounds per annum, of which perhaps one-third are evaporated apples.

Against sun-dried fruits of all kinds, no objection whatever is known to exist, but as the record shows, artificially evaporated apples, when dried in zinc or galvanized wire trays, may develop from contact sufficient salts of zinc to be detected when

imported to this country. The obvious remedy would seem to be to eliminate zinc entirely from the construction of every apparatus used to dry fruit for export. Wood has been used for this purpose, but it is open to two serious objections: the trays are liable to take fire when exposed to high temperatures, and contact with wood while drying discolors apples and impairs their market value. It is therefore suggested, as an easy way out of the difficulty, that fruit for the German market shall be either sun-dried or evaporated in trays of perforated tin or tinned-wire gauze, either of which, although more expensive than zinc, would soon repay the additional cost by wholly eliminating the present difficulty.

The sun-dried apricots, pears, peaches, and prunes of California and Oregon are recognized as superior to any others of whatever origin, and the two first named are rapidly taking possession of the German market. The import duty on such fruits from the United States is 95 cents per 100 kilograms (220.46 pounds), and they are retailed here at about 22 cents per pound (or half kilogram). It is somewhat remarkable that the best California dried fruits come from Chicago, where exporters take the trouble to send expert agents to the Pacific Coast during the gathering season, where they select and superintend the packing of the fruit.

Of fruits, as well as all other food products, only the best and purest should be exported to a country like Germany, where the laws protecting the public health are so searching and so rigidly enforced that the slightest defect is sure to be detected, and where the whole agricultural population is interested in opposing the importation of foreign products which compete directly with the home-grown supply.

FRANKFORT, May 22, 1895.

EXHIBIT A.

[Translation.]

Expert opinion concerning the harmlessness of American evaporated apples, given by the royal chief health officer, Privy Sanitary Counsellor Dr. Zimmermann, and Dr. Loock, chief inspector of the public food-inspection bureau for the city of Düsseldorf.

OFFICIAL ATTESTATION.

At the request of the merchant C. L. Fusbahn, of this city, and as an inclosure with the expert opinion of the municipal and court chemist, Dr. Loock, of this city, herewith presented, I hereby declare that through the eating of a large portion of apple sauce made of the dried apples in question, the amount of malate of zinc which would thereby be consumed by one person would not exceed one-fifth part of a normal dose of that salt which may be prescribed for small children without causing vomiting; and further, that from 0.5 to 1.2 grams of the acetate of zinc, which of all zinc derivatives is the most analogous to malate of zinc, are necessary to produce vomiting when administered to small children. In cases of adults, four times the same quantity would scarcely suffice to produce nausea or vomiting.

I therefore consider the eating of American dried apples as manifestly devoid of danger.

DR. ZIMMERMANN,

Chief Health Officer, Privy Counsellor.

DÜSSELDORF, November 30, 1892.

Certificate of Food Inspector Dr. Loock.

The city food-inspection bureau of the city of Düsseldorf has been charged from time to time with numerous chemical examinations of American dried apples, from official boards, business firms, etc. These analyses, which in general have tested the quality and quantity of salts of zinc contained therein, have shown the most various results, according to which the wholesomeness of the product is to be judged. A large part of these samples of apples have been found free from zinc. Of those which contained zinc, the greater portion show an admixture of from 0.01 to 0.05 per cent of zinc; the largest percentage found here has been 0.09 per cent.

Considering that evaporated apples are for the most part used as a material for compot (apple sauce), and that in the preparation of such material 100 grams of apples absorb about the same amount of water, and that since not more than 200 grams of compot, containing 100 grams of apples, are consumed by one person at a meal, it follows that through the consumption of that quantity not more than 0.09 gram of zinc salt would be introduced into the human organism, a quantity which, in view of the fact that such apples are not eaten regularly every day, would be quite insufficient to endanger human health.

Dr. LOOCK,

Chief of the City Bureau of Inspection, Düsseldorf.

DÜSSELDORF, November 28, 1892.

COLLECTION OF SAMPLES AT NEW YORK FACTORIES.

In view of the magnitude of the interests involved, further instructions were given in the autumn of 1895 to investigate the methods employed at some of the principal factories in northwestern New York devoted to the preparation of evaporated apples for the foreign market. The methods of manufacture which were observed in these factories have already been described. In addition to this a large number of samples of evaporated apples was secured. These samples were taken in person with the purpose of securing in a manner as representative as possible the different grades of the prepared fruit under conditions which would, after proper chemical analysis, determine definitely the occurrence of zinc in the products of manufacture and the conditions in which it occurred in maximum or minimum amounts. The samples secured will be sufficiently described in a tabular form hereafter.

During the course of this inspection buyers and shippers of evaporated fruits were interviewed and requested to give their experiences in seeking to sell the merchandise in foreign ports. Without exception, all exporters or dealers with exporters reported great difficulties experienced in certain German markets, and all were anxious for some method to be adopted whereby the objections to American evaporated apples might be removed and the markets of all Europe opened to them without sanitary restrictions.

VIEWS OF DEALERS IN EVAPORATED FRUITS.

In general, the views entertained by dealers and exporters are clearly set forth in the following extracts from correspondence:

From Messrs. Müller & Fückel, Hamburg, November 26, 1895:

We are under the impression that our authorities are at present using great leniency in the administration of the law which authorizes them to forbid the sale of evaporated apples contaminated with zinc. We, at least, do not remember that any lots here, during this year, have been confiscated for this reason. The contamination in all cases, as far as we know, was only a small one.

We have pleasure to send you by same mail two samples of evaporated apples which, according to an official analysis made here, are reported to contain 0.009 per cent and 0.004 per cent of zinc, respectively.

From Messrs. Pincoffs, Pieters & Co., Chicago, Ill., November 30, 1895:

We have no sample on hand at present of any apples of ours which have been found to contain zinc in Europe, but experience has taught us that careful and close chemical analysis will show some zinc in almost all evaporated apples, except those which are dried on wooden or canvas trays. We have given the matter a great deal of consideration, and naturally it has been of great importance to our business, and the trouble regarding this question which has arisen in Germany during the last few years has done a very great amount of harm to our business, as well as that of our fellow-exporters. It is a positive fact that the percentage of zinc in the evaporated apples is extremely small, and not enough to be of any harm to health, and this is in fact generally admitted by the medical authorities in Europe, but as the law in Germany does not define any percentage of zinc, it is no matter whether practically the article is not dangerous to health; as long as any percentage, however small, is found, the goods can be condemned according to their law.

We believe it is undoubted that a certain element of protection to home industries enters into this outcry against the American evaporated apples, but as no especial discrimination is made against the product of this country, and the law applies to all evaporated apples, whether of home or foreign make, we fear that it will be impossible for our Government to make any representation that could alter the decision of the German authorities. Our Mr. Pincoff's when abroad last year had occasion to investigate this matter fully, and also talked it over with our ambassador in Berlin. We are now exporting a good many apples which we guarantee to be entirely free from zinc, according to German analysis; and if evaporators will dry their apples on trays entirely free from any zinc, and be careful to have no zinc instruments of any kind connected with their evaporating establishments, this guarantee can be made with safety, and we believe it will be of great value if you will point out these facts in your forthcoming bulletin, a copy of which we would be very happy to receive.

From Messrs. Michael Doyle & Co., Rochester, N. Y., November 29, 1895:

We have had considerable trouble and annoyance for the past ten years by reason of the condemnation and rejection of evaporated apples which were reported to contain zinc oxids. The trouble at the present time is principally in the German Empire. It is due entirely to the efforts of local fruit growers to stimulate and encourage the evaporating apple industry in Germany, which has proven a failure there whenever attempted, for the reason that the apples are in too scanty supply, the prices too high, and the people without the technical knowledge necessary to make a good marketable quality at values which will compete with the product of our country. This is the secret of the whole difficulty. Of the thousands of tons used in this country, England, France, and the Scandinavian countries, not a single case of illness has ever been reported from the proper use of the fruit. The action of the German authorities is of about the same nature as that which they are waging against our meat and other products.

We are sorry to advise we have no samples of the goods reported to contain zinc, otherwise would be very glad indeed to send them to you.

From Charles J. Murphy, commissioner for the State of Iowa, U. S. A., London, January 18, 1896:

After considerable inquiry among local fruit dealers, I could find nothing against the evaporated apples (*in re* zinc), and finally called on the great house of Joseph Travers & Sons, whose letter I inclose, which speaks for itself.

From Joseph Travers & Sons, London, E. C., January 17, 1896:

In reference to your question as to the condemnation of American dried apples on account of their being injured by zinc, we have heard of no cases of the kind in England. The complaint originated, so far as we know, in Germany and found its way in the shape of an item of news into some of the English papers. Since your call we have made some inquiries and can hear of no case of the kind in London.

From L. R. Rogers, Albion, N. Y., January 24, 1896:

I am very sorry the analyses were not completed in time to report at Rochester the 22d instant.

Mr. Metcalf, of the firm of Metcalf & Ferguson, of Pittsburg, met me in Rochester with samples of aluminium wire cloth as a substitute for the present galvanized wire cloth so generally in use. I introduced Mr. Metcalf to a number of persons engaged in the evaporating business, who looked the samples over. All seemed interested in finding a substitute for the galvanized cloth. The objection to the samples seemed to be that they would not hold their position—that is, the wire would be moved to one side or out of position in scraping the fruit from the tray, thus ruining the tray very quickly. The galvanizing on the other style cloth holds the wire firmly in place; in fact, same is rigid.

Mr. Metcalf did not have samples of the perforated plates, but from the description of them think they will be just the article we want. He is to send me some samples of same in a few days, and later will send me some plates to be used in an experiment to be made to test them in actual work by the side of the aluminium wire cloth tray—and checked by the galvanized wire tray—in general use. I hope to be then able to find a substitute for the old method; also one that will work perfectly. After making the above experiments, I will report to you fully.

I am very sorry I can not make the experiments now, but the expense would be too great, and to be of any use they should be conducted for two or three days at least as varying atmospheric conditions might require. It is now so late in the season that apples do not handle as earlier in the season; that is, more solid and less juice. I therefore think the tests will be obliged to wait until early fall.

I was told in Rochester last night by the party who sold me the galvanized wire cloth I use on all my trays that same was free from zinc or any trace of zinc, as the firm who made same used tin instead. Therefore I could fully guarantee my evaporated apples free from zinc.

I await your answer with much interest.

From Messrs. E. Myers & Co., New York, February 3, 1896:

In accordance with your request to keep you posted on any developments which might come up in the matter of zinc found or claimed to be found in American evaporated apples in Germany, we herewith beg to hand you a translation of an article contained in the issue of the *Leipziger Zeitung*, January 16, 1896, on this subject. The original article in German is in our possession and of course is at the service of the Government if they consider it worth while to have it.

You will perceive that their own medical colleges recognize the absolutely harmless character of the worst specimens of American apples found to contain any zinc, even if consumed by the smallest of children. Under this statement of facts it should seem possible for our Government to bring about an amelioration of the police regulations which permit the prohibition of sale of this article of food when it contains the slightest trace of zinc, although recognized to be absolutely harmless to health.

Our trade has suffered most materially from this law, as has that of all other exporters of these goods, and we are all hoping for speedy relief through the action of our Government.

The secretary of the interior of the Kingdom of Saxony has received notice from the department of the interior of the German Empire that frequently dried apples, especially of American origin, are offered for sale which contain more or less zinc.

It is recommended, in order to protect the people against such danger, that special attention should be given to this article, and that from time to time samples should be analyzed, and, if necessary, sellers should be prosecuted.

In accordance with these suggestions the board of health of Dresden was ordered to take samples from various places where such apples were sold, to determine the quantity of zinc contained therein, and to report thereon.

By this report it was shown that in 7 of the 30 samples analyzed no zinc or only traces could be found, while the remaining 23 contained more or less zinc. In 14 of them the quantity of zinc oxid found in 100 grams of apples varied between 0.001 and 0.008 gram, which is equal to 0.002 to 0.021 gram malate of zinc. In the remaining 9 samples the quantity of zinc oxid found was larger, varying between 0.011 and 0.045 gram in 100 grams of apples=0.023 to 0.110 gram of malate of zinc. Taking into account that the minimum dose of zinc oxid for children is 0.05 gram three times a day, it can not be supposed that children should eat for any length of time three times a day 50 grams of apples. The board doubts if even the three samples with the highest percentage of zinc oxid (0.03 to 0.04 gram in 100 grams) could be called dangerous to health.

As it seems, however, that the department of the interior shares the opinion of some physicians, that apples with a percentage of 0.02 zinc could do harm to health if such apples should be taken in considerable quantities, the board has handed a copy of its report to the municipal board of the city of Dresden, stating the above-named facts.

METHODS OF ANALYSIS.

In the method of analysis employed by Professor Cornwall, the evaporated apples are extracted or digested with very dilute hydrochloric acid for several days. The liquid contents of the mass are separated by filtration, the filtrate concentrated to a small bulk, rendered strongly ammoniacal, and the zinc finally precipitated electrolytically as metal on platinum. In carrying out this process the presence of other metals capable of being electrolytically precipitated upon platinum must be excluded. Cornwall states that he found neither copper nor lead in any of the samples examined by him, but in a few cases iron was present, and the amount of it, as determined in the usual way, was deducted from the total weight of the metal weighed as zinc. In experiments made where known quantities of zinc were added to apples free of that metal, Cornwall found that 98 per cent of the added metal could be recovered by the process employed by him. He therefore regards it as meeting the requirements of accuracy in every respect. The chief objection to the process is found in the long time required in the preliminary digestion of the sample with hydrochloric acid. Cornwall further discovered that there was no connection between the zinc found and the color of the evaporated fruits.

HEFELMANN'S METHOD OF DETECTING ZINC IN EVAPORATED APPLES.

Hefelmann uses the following method for detecting zinc in evaporated fruits (*Chemiker-Zeitung*, vol. 18, p. 44):

Two hundred grams of the evaporated fruit are placed in a wide-neck flask and covered with enough 25 per cent hydrochloric acid to fully immerse all and allowed to stand, with frequent shaking, for three hours, at a temperature of from 40° to 60°. From two to three times as much water is added as the volume of the hydrochloric acid employed, and the flask is then placed aside, with frequent shaking, in a warm place for twenty-four hours. The contents of the flask are then filtered with the help of a suction pump, washed with 1 per cent hydrochloric acid and finally with boiling water. The extract is concentrated to about one-third of its volume and oxidized for half a day with small quantities of potassium chlorate. The free chlorine is driven off and the mass again filtered, the filtrate supersaturated with ammonia and treated with ammonium sulphide. After twelve hours the precipitate is separated by filtration and oxidized with aqua regia, heated until the chlorine odor has disappeared, strongly supersaturated with ammonia, acetic acid added, and the zinc sulphide precipitated with hydrogen sulphide. After the precipitation is complete, 10 grams of ammonium nitrate are added for each 100 cubic centimeters of the liquid in order to secure a better separation of the zinc sulphide, which, after standing for twenty-four hours, is separated by filtration and washed with water containing hydrogen sulphide and ammonium nitrate. It is then ignited and weighed as zinc oxid, the precipitate being washed with concentrated ammonium nitrate solution before ignition.

Hefelmann expresses the erroneous opinion that the white or yellow-white color and moist condition of American evaporated apples is due to their treatment with a zinc salt for bleaching purposes.

NIEDERSTADT'S METHOD OF DETERMINING ZINC.

At a meeting of the pharmaceutical section of the German Association for the Advancement of Science, at Lübeck, in September, 1895, Dr. Niederstadt, of Hamburg, read a paper on zinciferous apples. (*Chemiker-Zeitung*, vol. 19, p. 1757.)

Niederstadt uses the following method for the quantitative determination of zinc in evaporated fruits:

Forty grams of the finely cut apples are ignited in a platinum dish until the carbonized mass can be easily powdered in a mortar. This carbonized material is then extracted with hydrochloric acid, the extract separated by filtration and oxidized with potassium chlorate. Afterwards hydrogen sulphide is introduced to test for lead and copper, which if found are separated by filtration. The filtrate is again oxidized with potassium chlorate and the zinc and iron precipitated with ammonium sulphide, the precipitate separated by filtration, dissolved in hydrochloric acid, again oxidized with potassium chlorate, neutralized with sodium carbonate, acidified with acetic and the iron precipitated with sodium acetate and separated by filtration. In the filtrate the zinc is precipitated with hydrogen sulphide, separated by filtration, the zinc sulphide dissolved in hydrochloric acid, precipitated by sodium carbonate, and ignited. In this way 3 milligrams of zinc oxid which were added to apples free of zinc were recovered without loss.

LEGLER'S IMPROVED PROCESS.

Legler has improved the process described in the following way (*Chemiker-Zeitung*, vol. 19, p. 1763):

Fifty grams of the sample are thoroughly dried in a porcelain dish and with the flame of a gas lamp burned from above until thoroughly carbonized, so that the carbonaceous mass can be easily rubbed to a fine powder, an operation which can be conducted in the dish in which the drying takes place. The finely divided carbon is then extracted with hydrochloric acid at a boiling temperature in covered beakers, the solution diluted, filtered, and washed. To the filtrate an excess of ammonia is added and it is brought to a given volume. In an aliquot part of the filtrate, after the addition of acetic acid in slight excess, the zinc is precipitated with hydrogen sulphide and the excess of this gas removed by boiling. The zinc sulphide is then separated by filtration, dissolved and freed from iron, and finally ignited and weighed in the manner given above. In 100 grams of substance Legler found the following quantities of zinc: In three samples, from 40 to 60 milligrams of zinc; in one sample, from 20 to 30 milligrams; in six samples, from 10 to 20 milligrams; in fourteen samples, from 5 to 10 milligrams; in eleven samples, from 1 to 5 milligrams; in four samples, 1 milligram; in sixteen samples, none.

A comparison of the carbonizing method above described with the oxidation method, depending upon the use of potassium chlorate, showed that the two gave practically identical results. The great simplicity of the carbonizing method gives it, therefore, a decided advantage over the older method. At the temperature required for the carbonization there is no danger whatever of loss of zinc by volatilization.

FILSINGER'S METHOD.

According to Filsinger (*Chemiker-Zeitung*, 1894, vol. 18, p. 1239)—

It is not absolutely necessary to destroy the organic matter entirely before extracting the zinc, but under certain circumstances the hydrochloric acid extract of the organic matter can be used directly. In this case the hydrochloric acid is neutralized with soda lye, acetic acid added, and the solution treated directly with hydrogen sulphide. The precipitation of the zinc in this case is somewhat hindered by the organic materials which have entered into solution, but the precipitation will take place completely, especially if the solution when saturated with hydrogen sulphide be allowed to stand for some time. A quicker and safer method, however, consists in completely destroying the organic matter of the sample, say 50 grams, by treatment with hydrochloric acid and potassium chlorate.

METHODS OF ANALYSES EMPLOYED IN THE LABORATORY OF THE
DIVISION OF CHEMISTRY.

After a careful consideration of the different methods of analyses proposed, the method about to be described was adopted by the Division of Chemistry for the work of analysis of the samples collected. The analytical work for the determination of zinc was carried out by Mr. K. P. McElroy and for moisture and ash by Mr. Oma Carr.

Place the weighed portion of dried apples in a roomy platinum dish and heat cautiously over a low bunsen flame till the mass is thoroughly dry and ignition sets in. The flame is then removed and combustion allowed to proceed spontaneously. Should the burning cease it is to be reinstituted with the aid of the lamp. As a rule, however, the apples will burn of themselves. When the mass is all converted into ash and char, it is to be ground up in a porcelain mortar and extracted with hydrochloric or nitric acid. In the samples done in this laboratory hydrochloric acid was used. The residual charcoal is burnt to a white ash in the same platinum dish, the ash taken up in hydrochloric acid and the solution added to that first obtained. This solution is then filtered. To the filtrate bromine water is added to oxidize the iron, and the excess of bromine removed. A drop of methyl orange solution is placed in the solution and ammonia added till the reaction is only faintly though distinctly acid. Without regarding the precipitate produced, add 50 cc of a solution of ammonium acetate containing 250 grams of the commercial salt (Hess's method). The temperature is then carried to 70° or 80° and the liquid filtered into a liter flask. It is then washed with water of the same temperature till free of chlorids, though so much washing is hardly necessary in view of the limited amount of zinc oxid likely to be present. The filtrate is treated with hydrogen sulphid till saturated, allowed to stand till the zinc sulphid settles, and then filtered through an ashless filter. The filter is washed with a saturated solution of hydrogen sulphid containing a little acetic acid. Frequently, owing to the well-known peculiarities of zinc sulphid, it becomes necessary to return the filtrate several times.

The washed precipitate and containing filter are burnt in a porcelain or platinum crucible, highly ignited and weighed as zinc oxid. Results are good, though sometimes a little high, owing to coprecipitated iron phosphate. In a portion of 200 grams of fresh apples, to which was added a solution of zinc nitrate corresponding to 9.7 milligrams of oxid, 9.8 milligrams were recovered in one case, 10.3 in another. In another portion, to which 19.4 milligrams were added, 18.9 milligrams were recovered. Check samples of the same apples gave no zinc.

In the case of the samples analyzed, from 150 to 450 grams, depending on the size of the sample, were taken for each sample, burnt, and treated as described above, and dissolved. The resulting solution was made up to 300 cc, and duplicate portions of 50 cc each taken for analysis. In nearly all cases 450 grams were employed, and the 50 cc portions therefore represented 75 grams.

DESCRIPTION OF EVAPORATED APPLES AND OTHER ARTICLES ANALYZED.

No. 14075. From Seggermann Bros., 165 Duane street, New York; sample of parcel packed by dealer in Wayne County, N. Y., who buys from small manufacturers and makes one bulk of different lots received from different people.

No. 14076. From firm mentioned above; sample of apples dried on wire trays in one factory in Wayne County, N. Y.

No. 14077. From firm mentioned above; sample of apples dried on wire trays in an evaporator in Oswego County, N. Y.

No. 14078. From firm mentioned above; sample of apples dried on wire trays in a factory in Michigan.

No. 14079. From firm mentioned above; sample of apples dried on wooden trays in Wayne County, N. Y.

No. 14081. From E. Meyers, 436 Produce Exchange, New York; sample of evaporated apples dried on wire trays.

No. 14082. From firm last mentioned; sample of evaporated apples said to have been dried on wooden trays.

No. 14123. Received from Department of State; from United States consul-general at Frankfort on the Main, described in dispatch of Consul-General Mason of May, 1895, marked sample No. 1.

No. 14124. Same as above, marked sample No. 2.

No. 14150. Sample of dried apples described in letter of Frank H. Mason, consul general at Frankfort on the Main, dated June 22, 1895; this sample bears the seal and certificate of the police court before which the trial took place. See letter of consul-general of date mentioned, already given.

No. 14315*a*. From Müller & Fückel, Hamburg, Germany; according to an official German analysis, this sample is said to contain 0.009 per cent of zinc.

No. 14315*b*. From firm last mentioned; according to the official analysis, this sample is said to contain 0.004 per cent of zinc.

No. 14405. From factory at Walworth, N. Y.; sample taken by H. W. Wiley at the factory from a package put up for shipment.

No. 14409. From factory at Albion, N. Y.; sample taken by H. W. Wiley, October 30, 1895, from two car loads of evaporated apples prepared for shipment to Germany.

No. 14410. From factory mentioned above; sample taken as described above from a large pile of evaporated apples on floor ready for packing.

No. 14411. From factory mentioned above; taken as described from slices which fell off the tray after drying, without shaking, and thus not in contact, or only partially in contact, with the wire netting of the tray; tray had been in use for two years.

No. 14412. From factory last mentioned, being the slices that stuck to the wire cloth of the tray; same tray as above described. These pieces were therefore in intimate contact with the galvanized iron wires.

No. 14413. From factory last mentioned; slices of evaporated apples dried on trays new at the beginning of the season, September 25, 1895. Only those slices were taken that stuck to the trays, the loose ones having been shaken off.

No. 14414. From factory last mentioned; samples of evaporated apples dried on trays which had been in use more than five years. Only those chips were taken that stuck to the wire cloth.

No. 14415. From factory, Walworth, N. Y.; sample taken by H. W. Wiley, October 31, 1895; samples of evaporated apples dried on trays in use two years; these trays were greased about every third day with tallow to prevent the slices from sticking. The whole sample was taken, no attempt being made to get only those which were nearest the wire.

No. 14416. From factory last mentioned; sample taken as noted; sample of evaporated apples, including the skins and cores; manufactured expressly for the French trade, and to be used in making jellies, marmalades, and in flavoring wines.

No. 14417. From C. H. Perkins, Newark, N. Y.; sample of evaporated apples such as are placed on the general market; no data obtainable in regard to where or how the evaporation took place, except that it represented the product of western New York.

No. 14418. Sample of apples purchased from F. M. Walker & Co., 938 Louisiana

avenue SW., Washington, D. C. These apples were cored, pared, bleached, and sliced in the laboratory and were dried on trays made of pure aluminium wire.

No. 14418*a*. Two hundred grams of the fresh apples represented by No. 14418, evaporated and afterwards, to the evaporated fruit, 9.7 milligrams of zinc oxid in solution of dilute nitric acid added.

No. 14418*b*. A duplicate sample of 14418 treated as above.

No. 14418*c*. A sample of 200 grams of the fresh apples represented by 14418, evaporated and treated with 19.4 milligrams of zinc oxid in solution.

No. 14418*d*. Two hundred grams of fresh apples evaporated without addition of zinc.

Nos. 14418 *a*, *b*, *c*, and *d* were all evaporated on platinum.

Table showing per cents of moisture, ash, and zinc oxid in evaporated apples.

Serial number.	Moisture.	Ash.	Ash in dry substance.	Zinc oxid.	Zinc oxid in water-free substance.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
14075	15.41	1.077	1.27	0.0060	.0071
14076	15.14	.919	1.07	.0170	.0200
14077	15.41	1.075	1.27	.0078	.0092
14078	30.02	.578	.83	.0082	.0117
14079	18.40	.788	.97	.0021	.0026
14081	21.22	1.583	2.01	.0100	.0127
14082	31.23	.826	1.20	None.	None.
14123	18.26	1.201	1.47	None.	None.
14124	18.98	.971	1.20	.0100	.0123
14150	16.00	.522	.62	.0013	.0016
14315 <i>a</i>	18.55	.782	.96	.0072	.0088
14315 <i>b</i>	18.43	.982	1.21	.0112	.0137
14405	22.25	.826	1.06	.0096	.0124
14409	32.59	.851	1.26	.0216	.0320
14410	32.87	.809	1.21	.0148	.0220
14411	32.52	.913	1.35	.0066	.0098
14412	32.47	1.031	1.53	.0148	.0219
14413	33.06	.800	1.19	.0214	.0320
14414	30.58	.793	1.14	.0242	.0348
14415	27.08	.950	1.30	.0056	.0077
14416	23.11	1.022	1.33	Trace.	Trace.
14417	21.26	1.188	1.51	Trace.	Trace.
14418	-----	-----	-----	None.	None.
Means ..	23.85	.931	1.22	.0111*	.0152*
Maxima.	33.06	1.583	2.01	.0242*	.0348*
Minima.	15.14	.522	.62	.0013*	.0016*

* Exclusive of numbers 14082, 14123, 14416, 14417, and 14418.

In order to determine the number of milligrams of zinc oxid in 100 grams of the evaporated fruit, move the decimal points in the zinc oxid column in the above table three places to the right.

DISCUSSION OF DATA OBTAINED.

No. 14075. In this sample is found a fair illustration of what may be expected in a promiscuous lot of evaporated fruits purchased in a locality where drying on galvanized iron wire trays is commonly practiced. The amount of zinc oxid found in this sample, it is true, is extremely small, and expressed as per cent becomes almost a vanishing

quantity. Yet the analysis shows a weighable quantity of zinc in 100 grams. The amount ordinarily consumed by any one person in an ordinary meal would probably not exceed 100 grams, so that at the most not more than 10 milligrams of zinc would be introduced into his system, a quantity entirely too small to produce any harmful result. In giving the quantity of zinc found hereunder it is understood that it refers to the amount in 100 grams of the evaporated fruit.

In the next sample, No. 14076, is found a distinct increase in the quantity of zinc, and the fruit in question was known to have been dried on galvanized iron trays and not to have been mixed with other samples before the part for analysis was secured. The quantity of zinc found is nearly three times as great as in the first sample.

In the next sample, No. 14077, is found another instance of fruit known to have been dried on galvanized iron wire trays. A comparison between the two samples indicates how wide the variations may be under conditions which seem to be identical. The explanation of this is found in the fact that in a sample taken promiscuously it is possible at one time to secure a large number of slices which have been in intimate contact with the galvanized wire, and at another a majority of the slices may represent those which were not, or only in partial contact, with the wire.

In sample 14078 a small quantity of zinc is found, and the comment made on the preceding sample is equally applicable to this one.

In sample 14079 a trace of zinc was found amounting, in fact, to 2.1 milligrams. This sample was certified as having been dried on wooden trays. It was secured from a very large dealer, and it is entirely possible that a few slices of evaporated apples dried on galvanized iron may have found a place in it. A sample containing, however, so small a quantity of zinc as indicated could not possibly be condemned on any sanitary grounds, unless, indeed, the presence of even a trace of zinc in evaporated apples should be considered a sufficient reason for prohibiting their sale altogether. It must be remembered, also, that in quantities so small as those mentioned some allowance must be made for the ordinary errors in analysis, and unless a residue, which, for the quantity mentioned gives distinct qualitative reactions for zinc, is obtained the chemist can not positively testify to its occurrence.

In sample 14081, obtained from the same firm as the preceding, and purchased as having been dried on galvanized iron wire trays, a small quantity, amounting to 10 milligrams of zinc oxid, was found. No special comment is indicated on this sample.

In sample 14082, which was said to have been dried on wooden trays, not even a trace of zinc was found.

Sample 14123 is a sample of evaporated apples transmitted by Consul-General Mason, of Frankfort, accompanied by a dispatch to the State Department dated May 22, 1895. The sample is described in Mr. Mason's dispatch as one which had been condemned by the police authorities of

Frankfort on account of its alleged contamination with salts of zinc. Our analysis revealed the fact that this sample was entirely free of even a trace of zinc, and its condemnation therefore by the police authorities of Frankfort is completely unjustifiable.

In sample 14124, derived from the source mentioned above and marked sample No. 2, a small quantity of zinc was found, amounting to 10 milligrams of zinc oxid in 100 grams of the sample.

The sample 14150 was an officially sealed sample of evaporated apples taken from a lot, imported by Erwin Roelker, of Frankfort, from Albert Petrie, of Rochester, N. Y. As a result of an analysis made by the health authorities of Frankfort it was certified that the sample contained from 0.0035 to 0.9545 gram of zinc or salts of zinc per kilogram, a proportion which was adjudged prejudicial to human health. The sample bore the seal and certificate of the police court before which the dealer in these apples was tried. It was transmitted through the State Department by Consul-General Frank H. Mason, Frankfort on the Main, under date of June 22, 1895. This sample was found to contain but little more than a trace of zinc, viz, 1.3 milligrams in 100 grams, which is a little more than the minimum quantity certified to in the police records. It is difficult to understand why a sample which contained but little more than a mere trace of zinc could have been condemned for sanitary reasons.

Sample No. 14315*a* was sent by request of this Division by Müller & Fuckel, of Hamburg. According to an official analysis made in Hamburg for the health office this sample was said to contain 9 milligrams of zinc per 100 grams, or 0.009 per cent, which corresponds to a little over 11 milligrams of zinc oxid per 100 grams, a quantity which seems to be about the normal for the ordinary samples dried on galvanized iron wire.

Sample 14315*b* was received from the firm last mentioned, and, according to the official analysis, it was said to contain 0.004 per cent of zinc, which corresponds to 0.005 per cent of zinc oxid. In our analyses of these two samples the respective quantities of zinc contained therein were found to be 7.2 and 11.2 milligrams, respectively, for 100 grams. The two samples came without any distinctive marks, so that we were unable to determine the order in which they should come, except by the results of the analysis. It is evident, therefore, that the sample which we have marked *a* corresponds with the one containing, by the German analysis, 0.004 per cent of zinc, and the one marked *b* to the sample containing, by the German analysis, 0.009 per cent of zinc.

Sample 14405 was secured at a factory in Walworth, N. Y. A package which had been prepared for shipment was opened, its contents thoroughly mixed, and the sample for analysis taken. The fruit was dried on galvanized iron wire trays. It was found to contain the usual quantity of zinc oxid characteristic of fruit prepared in this way.

Sample 14409 was secured at a factory in Albion, N. Y. A car which

had been loaded for shipment was opened and a box of fruit taken at random, and the sample prepared from this box. The fruit was dried on galvanized iron wire. The quantity of zinc which we found in this sample was about double that usually found, and apparently by accident there was secured a large quantity of slices which had been in contact with the galvanized iron.

Sample 14410 was taken at the same place as the preceding from a large pile of fruit ready for packing. The analysis shows that it contains the usual quantity of zinc oxid. This fruit was dried on galvanized iron wire.

In securing the next sample, No. 14411, from the same factory as that above, an attempt was made to get as many as possible of the slices which had only been in partial contact with the wire. For this purpose a tray taken directly from the kiln was turned upside down and the slices which fell off without shaking were secured for analysis. As was to have been expected, the results of the analysis indicate a considerable diminution of the content of zinc, which was found to be only 6.6 milligrams of zinc oxid for 100 grams.

The next sample, No. 14412, consists of the slices which remained attached to the zinc when the tray was turned upside down, as indicated above. The quantity of zinc in this sample, viz, 21.4 milligrams of zinc oxid, is more than three times as great as that found in the preceding sample.

Sample 14414 consists of slices of evaporated apples which remained attached to the galvanized iron wires when a tray taken from the kiln was turned upside down. The tray on which the apples were dried had been in use more than five years. The sample contained 24.2 milligrams of zinc oxid per 100 grams. In comparing this with the preceding sample, which was dried on trays in use the first year, it is seen that the continued use of the tray does not tend to diminish the danger of contamination with zinc.

Sample 14415 was secured from another factory in Walworth, N. Y. The sample was dried on galvanized iron wire trays which had been in use for two years. The proprietor of the factory is in the habit of greasing his trays with tallow about every three days to prevent the slices from sticking thereto. The utility of this method is indicated in the low content of zinc found, viz, 5.6 milligrams for 100 grams of fruit.

Sample 14416, from the manufacturer mentioned above, represents the whole apple, including the cores and skins. The trays on which these apples were dried were also well greased, and only a trace of zinc was found in the sample.

In sample 14417 is seen an illustration of the character of the fruit which may be bought in the general market. The history of this sample could not be traced, but from the fact that it contained only a trace of zinc it is fair to presume that it was either dried on wooden trays or on galvanized iron trays which were kept well greased.

Sample 14418 represents a laboratory product prepared from apples purchased in the open market in Washington. These apples were put through as nearly as possible the process employed in the manufacture on a large scale, with the exception that they were dried on a tray made of pure aluminium wire. The analysis, as was to be expected, disclosed not even a trace of zinc.

EXAMINATION OF THE GALVANIZED IRON WIRE USED FOR MAKING THE TRAYS.

It was thought to be a matter of interest to examine the galvanized iron wire cloth used for making the trays employed in the manufacture of evaporated apples. For this purpose samples were secured at the factory of L. R. Rogers, Albion, N. Y., representing the unused material and also that which had been constantly employed in the factory for over five years. It would follow as a natural result from the use of this material that the zinc covering of the wire would gradually be dissolved by the acids of the apples and that in the end the iron core would be practically denuded. In practice, however, it is found that the constant rubbing of the trays to detach slices of evaporated apples wears them out before the zinc is entirely removed. The results of the analytical data which follow show, however, that a large percentage of the zinc originally enveloping the iron core is dissolved in the course of a few years. When the small quantity of zinc in a tray is taken into consideration, it seems unreasonable to suppose that any marked contamination of the product could ensue. Many thousand pounds of fruit are evaporated on a single tray before it becomes unfit for use. From the data which follow, however, it is seen that a tray having a surface of one square yard carries about 2 pounds of zinc. This would be sufficient to contaminate 20,000 pounds of evaporated apples with the average quantity of zinc oxid found therein in our analysis, viz, 10 milligrams per 100 grams. The analytical data of the examination of the wire cloth obtained by Mr. K. P. McElroy, follow:

EXAMINATION OF WIRE CLOTH,

No. 14406. Unused wire cloth, from L. R. Rogers:

Weight of 1 square yard of this cloth is 5.03 pounds. It is composed of 59.77 per cent iron and 40.23 per cent of zinc. On this basis 1 square yard would contain 2.02 pounds of zinc.

No. 14407. Unused wire cloth (one year old), from L. R. Rogers:

On handling this cloth particles of zinc scaled off freely. The weight of 1 square yard is 3.08 pounds. It is composed of 60.65 per cent iron and 39.35 per cent zinc. One square yard therefore contains 1.21 pounds of zinc.

No. 14408 A. Wire cloth in use more than five years, from L. R. Rogers:

Water extracts from this cloth traces of a soluble zinc salt, probably malate, and a little iron. The weight of a square yard of this cloth is 2.38 pounds. It is composed of 80.68 per cent iron and 19.32 per cent zinc. One square yard contains 0.46 pound of zinc.

No. 14408 B. Wire cloth in use more than five years, from L. R. Rogers:

Sample a part of the same lot as above. Water extracts a soluble zinc salt. The metal is composed of 84.77 per cent iron and 15.23 per cent zinc. One square yard weighs 2.18 pounds and contains 0.33 pound of zinc.

It is seen that there is a gradual disappearance of the zinc with use, the quantity in one tray dropping from about 2 pounds to one-third of a pound in five years.

PHYSIOLOGICAL ACTION OF ZINC.

It is probable that the zinc salts contained in evaporated apples exist entirely in the form of organic salts, the most abundant of which is zinc malate. The physiological effects of the organic salts of zinc have not been comprehensively studied, the only one used in medicine being the valerianate. The valerianate of zinc has antispasmodic properties and has also been used as a remedy in neuralgic affections. In general, however, the physiological effects of the zinc salts, as found in evaporated apples, may be assumed to be similar to those of the inorganic salts of zinc. The sulphate of zinc is the salt which is most generally used for medicinal purposes. It is tonic and astringent and in large doses produces prompt emesis.

There are a few cases on record of fatal poisoning from large doses of the salt. In one of the fatal cases an ounce and a half of the zinc sulphate was swallowed by mistake for epsom salts. A like quantity of the salt taken at the same time by another patient produced severe toxic symptoms, but did not result fatally. In many cases large doses of the salt have been administered for many days without any symptoms of toxic effects. In one instance 36 grains of salt were given three times a day for six weeks without the appearance of any symptoms of poisoning. All writers on toxicology, however, agree that in certain quantities zinc salts exercise a poisonous effect. While the continued administration of zinc salts in small quantities has not been known to produce any very decided disturbance of the physiological functions of the body, yet the continued administration of this substance even in minute doses can not be recommended. All authorities agree that even if zinc be regarded as poisonous it is decidedly less so than lead and copper. A case is recorded (in the *Chemisches Central-Blatt*, fourth series, Vol. I, 1894, p. 642) in which from 50 to 100 milligrams were administered every day for from two to six months without any disturbance in the health of the animals experimented on. Zinc does not accumulate in the system except in small quantities in the bones.

Zinc salts have also a certain antiseptic value and have been used to a slight extent for that purpose. They are also used to a very limited extent for fixing the chlorophyll colors of preserved vegetables, especially with pease and beans.

ZINC AS A NATURAL CONTENT OF APPLES.

There is one point of interest to analysts which should not be overlooked, viz, the possibility of zinc occurring naturally in plants. Researches of the past few years have shown naturally present in plants many metals which a few years ago were supposed never to enter the plant organism. It is possible that fruit trees growing in localities where zinc abounds may take this metal into their organs and fruits, as is the case with copper and other rare metals sometimes found as natural products in plants. It would be of interest to have fruits which grow in localities where the soil is known to contain zinc examined for this substance. If it should be found that plants have the power of absorbing zinc, the presence of a mere trace of this substance in evaporated apples would no longer be conclusive evidence of their having been dried on galvanized iron wires. According to Filsinger (*Chemiker-Zeitung*, 1894, vol. 18, p. 1239) there is already sufficient evidence on record of the ability of plants to absorb zinc to render permissible the question as to whether traces of zinc found in American evaporated apples might not arise from the soil on which the orchards stand.

SUBSTITUTION OF OTHER MATERIAL FOR GALVANIZED IRON WIRE IN THE MANUFACTURE OF TRAYS.

The results of the investigations which have been conducted show that as long as galvanized iron wire trays are used for evaporating apples it is not possible to guarantee that the product shall be free of zinc. The difficulty of securing even drying on wooden slats and the fragility of trays made of cloth are sufficient reasons for excluding these two materials from consideration in the manufacture of drying trays. The fact that aluminium is now manufactured at a very cheap rate suggested the possibility of using this material in making trays. With this purpose in view, inquiries were directed to the Pittsburg Reduction Company in regard to the matter. This company showed a lively interest in the question and kindly made, for the use of this Division, 12 square feet of aluminium wire netting suited to the purpose required. This wire at the present time costs 90 cents a pound, which would indicate that the cost of the aluminium in a square yard would be a little over 60 cents. If there were much demand it could probably be made for very much less. There would probably be one practical difficulty in the use of the aluminium wire netting, arising from the fact that the strands not being soldered together might be displaced by the wooden paddle which is used in scraping the dried apples from the tray. The spaces in the netting would thus become unequal and possibly in some cases large enough to allow the slices to fall through. It has been suggested to use perforated sheet aluminium for the bottoms of the trays. If this could be done it would remove the difficulty mentioned above.

Only experience will show how long the aluminium wire would withstand the action of the acids of the fruit. It is not probable, however,

that it would be dissolved at any greater rate than the zinc of the galvanized iron. The small quantity of alumina which would be introduced into the fruit could not possibly be regarded as objectionable.

It would be useful also to substitute iron wires covered with tin for the galvanized iron at present in use. Wire netting could be prepared and covered with tin at a much less expense than aluminium could now be furnished. The coating of tin, evidently, for such a purpose should be much heavier than that for ordinary tinware, so that the iron may be in all points deeply covered, and thus avoid the galvanic action which would ensue on the portion of iron exposed. The tin employed should be pure, and especially free of lead. Pure tin is much more resistant to the action of acids than zinc, and the amount of tin which would be found in evaporated fruits dried on tin trays would probably be infinitesimal.

While it is true that it would cost the manufacturers a considerable sum to throw away the trays which they now have and substitute for them those which would cost a great deal more money, yet the expense seems to be worth incurring. To be able to absolutely guarantee the product free of zinc would result in opening a wide and profitable market to our evaporated fruits, and in the removal of any justifiable hygienic reasons for restricting their sale.

SUMMARY.

(1) In many European markets the consumption of American evaporated apples is either restricted or prohibited by alleged hygienic reasons resting upon the supposed contamination of the product with zinc.

(2) In several cases where samples of condemned products have been secured through the agency of our consuls and others, an analysis has disclosed the presence of zinc in some of them and proved its absence in others. In the latter case the prohibition of the sale of the product was evidently discriminating and unjust.

(3) In samples of American evaporated apples secured from large dealers and directly from the factories, weighable quantities of zinc have been found in nearly every instance in which the drying was accomplished on galvanized iron wire trays.

(4) The results of the analyses have shown that the slices which were dried in intimate contact with the galvanized iron wire contained a far larger content of zinc than those in which the contact was less intimate.

(5) An analysis of the galvanized iron wire cloth composing the bottoms of trays shows that in each square yard of the new cloth about 2 pounds of the zinc are present, and that when these trays have been in use for several seasons the total quantity of zinc is very much diminished, but that still considerable quantities are present when the trays are too much worn for further use.

(6) It has been seen that the age of the tray does not greatly affect the quantity of zinc which is contained in evaporated apples.

(7) Experiments have shown that pure aluminium wire may be used for making the netting on which the apples are dried, and it is probable that perforated sheet aluminium may also be found useful for this purpose. By the use of pure aluminium the presence of zinc could be entirely excluded from the evaporated fruits, and thus all hygienic objections to their use would fall. The presence of the minute amount of alumina which would be introduced into the evaporated fruit would be of no consequence, inasmuch as alumina is a natural constituent of nearly all food products. Well-tinned iron wire would also make an acceptable substitute for the wire covered with zinc now in use.

(8) The manufacturers of evaporated apples in this country should at once rigidly exclude all galvanized iron utensils from their factories and substitute therefor drying trays composed of aluminium, tin, or some other substance which will not permit of any objectionable ingredient entering the finished product. The use of bronze cutting instruments should also be excluded and steel substituted.

(9) The physiological effects of the organic salts of zinc are not well understood. The inorganic salts of zinc taken in large quantities act as irritant poisons. Small quantities of zinc salts are constantly administered in the practice of medicine, producing tonic and astringent effects. The continued use of small quantities of zinc for a long period of time has not been known to produce any serious results. Experience has shown that zinc is distinctly less poisonous than copper or lead.

(10) The normal quantity of zinc in the form of oxid found in American evaporated apples which have been dried on galvanized iron trays is about 10 milligrams for every 100 grams of the fruit, or a little less than 50 milligrams per pound. One grain, druggists' weight, is equivalent to 65 milligrams. The quantity of zinc, therefore, in 1 pound of evaporated apples dried on galvanized iron trays is only about two-thirds of a grain. The quantity of zinc which would be taken by any one person in an ordinary meal at which dried apples were served would probably in no case ever exceed two-fifths of a grain. It is not possible to regard this quantity as in any way prejudicial to health.

(11) The continued use of bodies which are not distinctly poisonous, but which are foreign to the natural constituents of the system, may finally produce derangement of health, and for this reason the manufacturers of evaporated fruits in this country should pursue such processes as would exclude even the traces of zinc above mentioned.

(12) American dried apples contain nearly one quarter of their weight as water and ash, the mean percentage of water in the samples examined being nearly 24 and of ash nearly 1.25. The extreme variations in moisture from the mean were found to be about 8 per cent.

INDEX.

A.

	Page.
Aluminum for making drying trays.....	34
Analyses, method used in laboratory.....	26
Analytical data, table.....	28

B.

Bailey, Prof. L. H., drying kilns.....	10
Bleaching apples.....	8

C.

Carr, Oma, analytical work.....	25
Cologne, restrictions in trade in dried apples.....	14
Cornwall, Prof. H. B., analysis of evaporated apples.....	8
method of analysis.....	23

D.

Data, discussion.....	28-31
Doyle (Michael) & Co., letter from Rochester.....	21
Dresden, action of board of health.....	23

E.

Evaporated apples, analysis of New Jersey samples.....	8
authority for investigation.....	7
description of samples.....	26, 27
drying on wood.....	11
insects found.....	9
investigation by the Department of Agriculture.....	15
packing.....	11
restriction in trade.....	12
sorting.....	11
superiority of American.....	11
wholesomeness.....	12

F.

Filsinger, Dr., method of analysis.....	25
Frankfort, legal proceedings against dealers in dried apples.....	17, 18
regulations of trade in dried apples.....	15

G.

Galvanized iron wire, analyses.....	32
German Government, action.....	16, 17

H.

Hamburg, restrictions in trade in dried apples.....	12, 13
Hefelmann, Dr., method of analysis.....	24
Hilgard, Prof. E. W., sulphuring apples.....	9

I.

Insects in evaporated apples.....	9
-----------------------------------	---

L.

	Page.
Lattimore, Prof. S. A., analyses of evaporated apples	7
Legler, Dr., method of analysis	25
Letter of transmittal	3
Loock, Dr., certificate of food inspector of Düsseldorf	19

M.

Mason, Frank H., report of United States consul at Frankfort	15
McElroy, K. P., analytical work	25
Methods of analysis	23, 26
Müller & Fückel, letter from Hamburg	20
Murphy, Charles J., letter from London	21
Myers (E.) & Co., letter from New York	22

N.

Niederstadt, Dr., method of analysis	24
wholesomeness of evaporated apples	12

P.

Paring apples	10
Pincoffs, Pieters & Co., letter from Chicago	21
Poisoning by zinc sulphate	33

R.

Ringäpfel	11
Robertson, W. Henry, report of United States consul	12
Rogers, L. R., letter from Albion, N. Y	22

S.

Samples collected for analysis	20
description	26, 27
Sulphuring apples	8
after evaporation	9
process	10
Summary	35, 36

T.

Table of analytical data	28
Tin for making drying trays	35
Travers (Jos.) & Co., letter from London	22
Trays, composition of galvanized iron wire	32

W.

Wamer, William D., report of United States consul	14
Wire cloth, analyses	32

Z.

Zimmermann, report of chief health officer of Düsseldorf	19
Zinc, occurrence in plants	34
physiological action	33
salts, antiseptic properties	33
coloring properties	33

